
The Social Aspects of the Tree-Ring Analysis

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Abstract:

The work presents a study of wooden beams from the Assumption Cathedral in the Island Town of Sviyazhsk. A total of five floating chronologies of different lengths were obtained as a result of tree-ring analysis.

Cross-dating demonstrated that the trees were cut in a single time period in the 1560s.

Keywords: Pine, Free-Ring Chronology, Dating, Archaeology.

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1. Introduction

The Assumption Cathedral is located in the Eastern part of the the Russian Plain in the Island of Sviyazhsk, Tatarstan Republic, Russian Federation. The Cathedral represents unique cultural heritage of the 16th century built during the reign of Ivan the Terrible. In 2017 it became a UNESCO Cultural Heritage Site.

The Assumption Cathedral was constructed using a technology of column strengthening with the application of wooden pillars fitted between the columns. Grooves were provided in the columns, in which the logs were inserted. The technology was indeed very efficient. It is evidenced by the fact that when the wooden pillars were sawn off in the twentieth century, it caused immediate problems associated with the stability of the temple. Cracks appeared in the vaulted portion, and the columns and walls began to move. When the pillars were sewn off, their portions located within the walls remained. This outstanding discovery provided great opportunities for the dating of the building. More than ten pillars of the kind were discovered.

It was assumed that the studied timber was pine of a single origin and calendar period of cutting. Xylotomic and tree-ring analyses were used in order to confirm the assumption.

2. Object and methodology of research

A total of six wooden pillars located on the second tier of the Cathedral were studied in 2015 as discribed in Table 1.

Tables 1: *Description of the wooden beams located on the second tier of the Cathedral.*

Object code Log No.	Pillar	Facet
USP 01	Southwestern	Western
USP 02	Southern wall	-
USP 03	Southwestern	Northern
USP 04	Northwestern	Western
USP 05	Southeastern	Southern
USP 06	Northeastern	Eastern

Since the studied logs were cut flush with the wall, the researchers had no opportunity to sample the cores with a drill perpendicularly to the longitudinal axis of the trunk. The issue was resolved by using the method of digital photography of annual rings. For the purpose, the researchers polished the surface and took macrophotographs of saw cuts. Coorecorder 7.1 (Larsson & Larsson, 2013) software was used in order to mark annual rings and measure their width. Tree-ring chronologies were provided on the basis of measurement results. The chronologies were dated using the cross dating

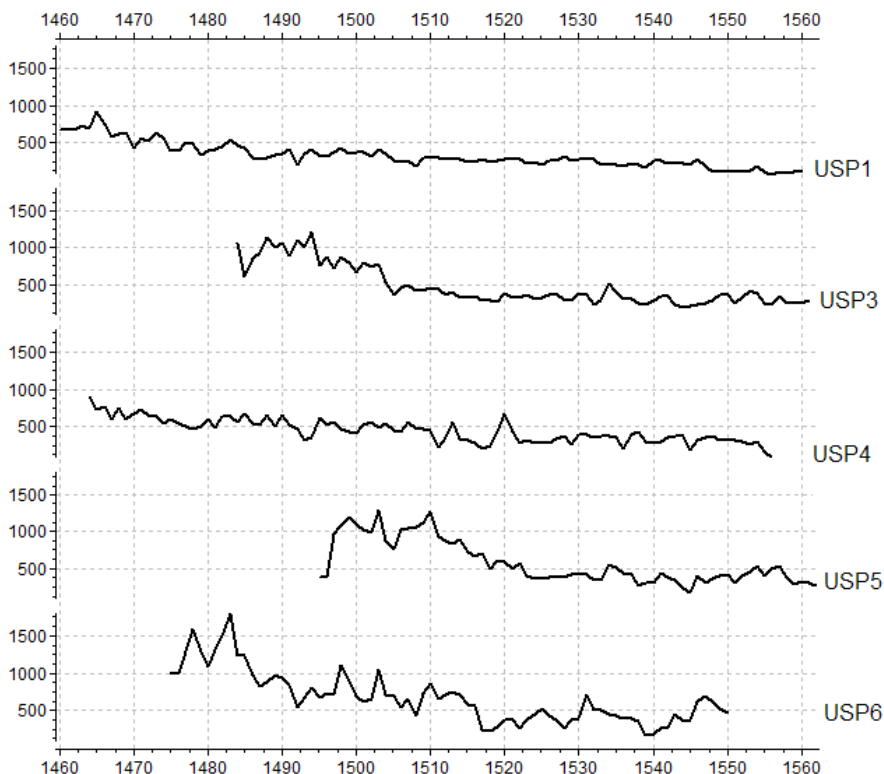
technique on the basis of scales obtained from local historical timber. The origin of timber was determined with the use of a database of chronologies from a dendrochronology laboratory of the Institute of Geography of the Russian Academy of Sciences (Moscow). The quality of dating was assessed using Cofecha software (Holmes, 1995). Cross-dating was conducted with the use of statistical characteristics calculated in the Rinntech TsapWin software (Rinn, 2003): Gkl - synchronization coefficient, CDI - cross-dating index, Gsl - reliability, etc.

3. Results

A xylotomic analysis of five samples collected from the logs demonstrated that the investigated timber belongs to the *Pinus sylvestris* L. species (pine).

A total of five floating tree-ring chronologies of different lengths were compiled as a result of the tree-ring analysis (Figure 1).

Figure 1: Floating tree-ring chronologies.



Floating tree-ring chronologies compiled on the basis of the logs of the Assumption Cathedral. The ordinate is the width of the annual rings, mm \times 100.

The average age of the cut-down trees used for the construction of the temple is 82 years, and the maximum age is 101 years (USP01). A comparison of individual chronologies demonstrated high correlation, especially between USP 05 and USP 06 (Table 2).

Tables 2: *Correlation links between USP chronologies*

Sample code	Correlation and synchronization		
	Glk	Gsl	CDI
USP01/05	62	*	22
USP01/06	64	*	21
USP05/06	65	**	25

The results of cross-dating and the characteristics of chronologies are presented in Table 3.

Tables 3: *Characteristics of USP floating chronologies*

Sample ID	Years (relative)	Average tree-ring width (mm)	Mean sensitivity	1st order autocorrelation	Correlation
USP01	1460-1560	3.34	0.18	0.89	0.31
USP03	1484-1561	4.74	0.19	0.89	0.20
USP04	1464-1556	4.48	0.20	0.75	0.11
USP05	1495-1562	5.77	0.18	0.88	0.40
USP06	1475-1550	3.78	0.21	0.86	0.40

On the basis of obtained results, it can be assumed that the trees come from a single forest and were cut down in the same period of time between 1556 and 1562.

A search for links with chronologies based on local timber was conducted. For this purpose, series of samples were taken (the DENDROCHRON chronology database of the laboratory of the production ecology under Kazan Federal University) compiled on the basis of sites located in the Republic of Tatarstan. Cross-dating of the chronologies of the Assumption Cathedral was conducted with the use of samples from other regions of Russia (Kirillo-Belozerski Monastery (Vologda Region), Church of St John Divine (Yaroslavl Region), Church of St. Nicholas, Kostroma Region, Church of the Holy Ascension (Arkhangelsk Region), Cathedral of the Blessed Virgin Mary (Kostroma region). As a result of cross-dating of the USP with other chronologies, low correlation and synchronization values were obtained (t-value less than 4). Therefore, the construction timber is of local origin

4. Acknowledgements

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